

SYSTEM AND METHOD FOR AUTOMATED RISK ANALYSIS AND/OR
OPTIMIZATION OF THE SERVICE LIFE OF TECHNICAL
FACILITIES

5 The invention relates to a device and a method for
automated optimization of the service life of technical
facilities and/or risk management and/or risk
determination of technical facilities, wherein facility
data are captured by means of a capture module of an
10 optimization system and facility risks are optimized by
means of an evaluation module of the optimization
system on the basis of the facility data. In
particular, the invention relates to an automated
and/or computer-aided device and/or a corresponding
15 method for risk management of portfolios of securities
and/or insurance policies etc. in conjunction with
technical facilities.

The service life of technical facilities is of great
20 significance economically. On the one hand, the failure
of a facility or parts of the facility mean a
production failure and, on the other hand, this risk
ties up production resources. In highly technical
facilities, in particular, an increasing number of risk
25 factors play an important role in view of a possible
service interruption. Use, for example of computer
technology or highly sensitive technical facility
components especially, will complicate an evaluation,
on the one hand, and, on the other hand, an
30 optimization of the service life of the technical
facility.

From the prior art, systems for automatic monitoring of
facility elements and/or protection elements, for
35 example, are known. The advantageous factor in such
systems is that operating failures can be located and
possibly corrected within a relatively short period.
The disadvantageous factor is that this system provides
neither evaluation of the service life to be expected

nor its optimization. In addition, such systems are exclusively suited to monitoring objective and quantitative detectable risk elements such as, for example, temperature, speed of a motor or the like.

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In US publication 2003/004128 A1, a system for evaluating risks in an information system is described which makes it possible to calculate, for example a service life to be expected, by means of probabilities.

10 The system has a capture module for capturing the risk data in a database and an evaluation module for calculating the total risk. The term risk is defined as a product of potential damage and the probability that this will happen. The disadvantageous factor in this

15 known solution is that, for a comprehensive evaluation of the service life to be expected, quantities which cannot be objectively acquired also play a significant role which remain unconsidered in this known system. Furthermore, the determination of the potential damage

20 and the probability that this will happen proves to be extremely difficult.

Another problem based on the difficulty of assessing technical facilities within one type of industry and

25 across types of industry with respect to their risk of an operating failure etc. is known from the risk management of portfolios of securities or funds. Within a portfolio, the risk of individual securities should be mutually balanced as well as possible. The systems

30 known in the prior art typically comprise assumptions and theories about the economic force and aims of the portfolio such as, e.g. high return of investment and/or low investor risk. For the calculation, the system takes into consideration, e.g. business data

35 and/or stock exchange data. This can include, for example, historical stock exchange data, balance sheet information and/or the profit shown. According to experience, however, financial analysts frequently change in the industry, with the consequence that the

company strategy of the individual companies can change just as frequently and unpredictably. This can scarcely be taken into consideration with the systems of the prior art without requiring substantial intervention in
5 the system every time.

It is an object of the present invention to propose a novel system and a method for automated risk management and/or automated optimization of the service life of
10 technical facilities which do not have the above-mentioned disadvantages of the prior art. In particular, an automated, simple and efficient system and method are to be proposed which also reliably assess complex technical facilities by automated means.
15 On the basis of this assessment, automated risk management of the technical facility and optimization of the protection devices and service life compared with other technical facilities should be possible. It is also an object of the invention to provide for an
20 automated, transparent and user-friendly risk management of a portfolio of securities based on technical facilities. This risk management should be able to adapt to changed conditions dynamically and by automated means.

25 According to the present invention, this object is achieved, in particular, by the elements of the independent claims. Other advantageous embodiments are also found in the dependent claims and the description.

30 In particular, these objects are achieved by the invention in that, for the purpose of automated optimization of the service life of technical facilities and/or risk determination of technical
35 facilities, the device and/or the computer-aided system comprises a capture module for capturing facility data and an analysis module for analyzing the facility data and/or optimizing the service life of the facility, that the capture module comprises at least one

measuring device and/or sensor, connected to the device via a network in a decentralized manner, with corresponding interfaces for determining one or more facility-specific quality factors, the measuring device
5 and/or sensor being allocated to a particular technical facility, that the optimization device comprises a first database with predefined risk elements, wherein a risk instance and/or a risk potential of the technical facility can be detected in a quantified manner by
10 means of a risk element, that the optimization device comprises a second database with predefined protection elements, wherein a protection device and/or a protection possibility of technical facilities can be detected in a quantified manner by means of a
15 protection element, that at least one risk element and/or at least one protection element is stored allocated to the technical facility, wherein a facility-specific weighting factor can be determined for each risk element and protection element, which
20 weighting factor comprises the relative weighting ratio of the risk elements and/or protection elements with respect to one another, that a facility-specific quality factor can be determined for each risk element and protection element by means of the at least one
25 measuring device and/or sensor, wherein the quality factor comprises the instantaneous facility-specific instance of a technical risk element or protection element on the basis of the measured facility data, and that the optimization device comprises an evaluation
30 module for determining risk analysis values and/or facility optimization values on the basis of the sum of the products of the risk elements with associated weighting factors and quality factors combined with the sum of the products of the protection elements with
35 associated weighting factors and quality factors. This variant of an embodiment has the advantage, among other things, that technical facilities can be optimized and/or monitored and compared by automated means. This relates both to a possible service life and to security

and/or risks of operating the facility. By means of a comparison, the facilities can also be optimized with respect to other factors. This includes, e.g. risk minimization/required investment with respect to
5 insurances policies, share prices etc. Using the method, the comparison can be made by automated means on the basis of current operating data which is not possible in any way with other devices and systems of the prior art. The system and method also have the
10 advantage that it [lacuna] automated administration of securities and/or insurance policies portfolios etc. which is always up-to-date, including data which are not only based on balance sheet and stock exchange data of the companies. In particular, short-term changes in
15 management and/or leadership of the companies are also taken into consideration automatically.

In one variant of an embodiment, at least two types of facility risk are generated and stored in a memory
20 module of the optimization system, wherein the types of facility risk in each case comprise at least one risk element and/or one protection element and one type of facility risk can be allocated to each technical facility, and for each type of facility risk, a
25 reference value is generated, wherein the facility data of different technical facilities are normalized to the reference value of the associated type of facility risk by means of a normalization module. As a variant of the embodiment, the types of facility risk can be
30 preferably generated in such a manner that a technical facility can always unambiguously be allocated to in each case one type of facility risk. This variant of the embodiment has the advantage, among other things, that different technical facilities can be compared
35 with one another in a normalized manner. On the one hand, this allows improved and up-to-date assessment of the technical facilities with respect to one another. In addition, portfolios can be balanced out with

respect to their risk on the basis of the current state of the facilities.

5 In another variant of an embodiment, the types of facility risk and/or the associated reference values are generated dynamically. This variant of an embodiment has the advantage, among other things, that the types of facility risk and/or the associated reference values can be obtained as up-to-date as
10 possible at all which allows quick response to short-term changes. This is achieved, in particular, without generating additional work, time and/or cost expenditure.

15 In a further variant of an embodiment, a two-dimensional matrix table is generated and stored in accordance with the combination, in which table a first dimension is allocated to the protection level of a technical facility and a second dimension is allocated
20 to the risk level of a technical facility. For the automated risk management and/or automated optimization of the service life of the technical facility, the sum of the products of the protection elements with associated weighting factors and quality factors of the
25 technical facility will be entered in accordance with the first dimension and the sum of the products of the risk elements with associated weighting factors and quality factors of the technical facility will be entered in accordance with the second dimension, and
30 the at least one risk analysis value and/or facility optimization value is determined on the basis of the location of the entry in the matrix table. In a variant of an embodiment, the matrix table can be divided into predefinable sectors, a sector corresponding to at
35 least one definable risk analysis value and/or facility optimization value. This variant of an embodiment has the advantage, among other things, that it allows simple and quick assessment or evaluation of the technical facility. This method also simplifies the

evaluation of changes made with respect to its effectiveness in comparison with other technical facilities.

5 In another variant of an embodiment, the matrix table is normalized by means of a facility-risk-specific normalization factor for determining the risk analysis values and/or facility optimization values for a technical facility. The facility-risk-specific
10 normalization factor can be generated dynamically on the basis of available facility data of technical facilities of the corresponding type of facility risk. This variant of an embodiment has the advantage, among other things, that technical facilities can be compared
15 with one another independently of their type of facility risk. Thus, e.g. portfolios of securities and/or portfolios of insurance policies etc. can be optimized or minimized, respectively via different types of facility risk with respect to their facility
20 risk and/or return of investment.

In one variant of an embodiment, the scale of the first and/or second dimension of the matrix table is linearly selectable. This variant of an embodiment has the
25 advantage, among other things, that dependences can be detected and represented in a simple manner.

In another variant of an embodiment, the scale of the first and/or second dimension of the matrix table can
30 be nonlinearly selected. This variant of an embodiment has the advantage, among other things, that complex nonlinear dependencies can also be detected and represented in a simple manner. This simplifies the assessment of the technical facilities or portfolios.
35 In addition, this simplifies and accelerates possible optimization of the technical facility or of the portfolios.

In one variant of an embodiment, the risk analysis values and/or facility optimization values for possible combinations and weightings of the protection elements and/or risk elements are automatically generated, and
5 stored accessible to a user, by means of an extrapolation module. This variant of an embodiment has the advantage, among other things, that local and/or global optimizations can be performed by automated means by means of the extrapolation module. In
10 particular, such optimizations can be supplemented by one or more neural network units of the extrapolation module.

In one variant of an embodiment, a group risk factor is
15 allocated to each type of facility risk by means of the evaluation module, the group risk factor comprising the overall risk of all technical facilities of a type of facility risk. This variant of an embodiment has the advantage, among other things, that types of facility
20 risk can be compared across types and technical facilities can be correspondingly optimized or, e.g., insurance policies can also be calculated.

In another variant of an embodiment, the group risk
25 factor is generated dynamically by means of an evaluation module. The group risk factor can be generated, e.g. on the basis of facility data. This can be generated, for example, once or periodically. This variant of an embodiment has the advantage, among other
30 things, that the group risk factor can be obtained as up-to-date as possible at all which allows quick response to short-term changes. In particular, this is achieved without generating additional work, time and/or cost expenditure.

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In one variant of an embodiment, the capture module is arranged accessibly in a decentralized manner via a network. This variant of an embodiment has the advantage, among other things, that the system and/or

the method can be provided by corresponding service providers without each technical facility being able to comprise the entire system. This has the advantages, among other things, that cost and/or time expenditure
5 can be optimized or reduced, respectively.

In another variant of an embodiment, groups of protection elements are formed by means of evaluation module with one or more protection elements as knock-
10 out protection elements, so-called red flags, wherein a knock-out protection element determines the behavior of the entire [lacuna] if a given limit value of the knock-out protection element is reached. This has the advantage, among other things, that mutual dependencies
15 of risk elements and/or protection elements can be detected and correspondingly taken into consideration in the system and/or method.

It should be noted at this point that the present
20 invention is based, apart from the method according to the invention, also on a device and a computer-aided system for carrying out this method. Furthermore, it is not restricted to the system and method mentioned but also relates to a computer program product for
25 implementing the method according to the invention and a corresponding portfolio management system.

In the text which follows, variants of embodiments of the present invention are described with reference to
30 examples. The examples of the embodiments are illustrated by the following figures attached:

Figure 1 shows a block diagram which diagrammatically illustrates the architecture of a system according to
35 the invention for automated risk management and/or automated optimization of the service life of technical facilities.

Figure 2 diagrammatically illustrates the architecture of a part of the optimization system 10 according to the invention, wherein a type of facility risk RA comprises one or more risk elements RE_i and/or one or more protection elements SE_i and a weighting factor GR_i and GS_i and a quality factor QR_i and QS_i is stored allocated to each RE_i and SE_i , respectively.

Figure 3 shows a diagram which diagrammatically reproduces the operation of the matrix table in which a first dimension is allocated to the protection level of a technical facility 20, 21 and a second dimension is allocated to the risk level of a technical facility 20, 21.

Figure 4 also shows a diagram which diagrammatically reproduces the operation of the matrix table, wherein, for example for the purpose of portfolio management, protection devices and facility risk of different facilities are arranged distributed around a reference value in order to minimize the risk of the portfolio.

Figure 1 diagrammatically illustrates an architecture which can be used for implementing the invention. In this exemplary embodiment, facility data 201, 202, 211, 212 are captured by means of a capture module 11 of an optimization system 10 for the purpose of automated risk management and/or automated optimization of the service life of technical facilities 20, 21. By means of the facility data 201, 202, 211, 212, facility risks will be optimized by means of an evaluation module 12 of the optimization system 10 on the basis of the facility data 201, 202, 211, 212. Capture module 11 and evaluation module 12 can be constructed as hardware and/or software, e.g., by suitable means. The optimization system 10 generates a list 141 with risk elements 1410, 1411, 1412 and stores them in a first database 14. A risk instance and/or a risk potential of technical facilities 20, 21 can be captured in a

quantified manner by means of a risk element 1410, 1411, 1412. Risk instance and/or risk potential of technical facilities 20, 21 are, e.g. fire hazard, closeness to water, earthquake hazard, susceptibility to wear and/or tear etc. etc. For example, risk elements can also be captured on the basis of corresponding groups. Examples of this would be, among other things, environmental hazards such as the immediate or indirect neighborhood of the technical facility, earthquakes, flooding, drought, hurricanes, etc., design-related risks such as building construction, arrangement of the technical facilities in the buildings, electrical and/or sanitary installations etc., process risks such as heat-dependence (fire etc.), process hazards, sensitivity to smoke and other contamination, age of the facility. The optimization system 10 generates a list 151 with protection elements 1510, 1511, 1512 and stores them in a second database 15. A protection device and/or a protection possibility of technical facilities 20, 21 can be detected in a quantified manner by means of a protection element 1510, 1511, 1512. Protection possibilities and/or protection devices include, e.g. fire alarm, number of available fire extinguishers, water sprinkling systems for fighting fire, distance from the nearest fire department but also maintenance expenditure invested, corporate culture and care etc. etc. The protection elements can also be covered, e.g. in groups such as, e.g. prevention measures such as water supply, availability and accessibility by the fire department, fire detection devices, fire extinction devices etc. or administrative measures such as maintenance of the facility, frequency of inspections, training of staff members, risk management applied etc.

At least one risk element 1410, 1411, 1412 and/or protection element 1510, 1511, 1512 is stored allocated to the technical facility 20. For each risk element

1410, 1411, 1412 and protection element 1510, 1511, 1512 allocated, a facility-specific weighting factor G_{20_1} , G_{20_2} , G_{21_1} , G_{21_2} is determined by means of the optimization system 10. The weighting factor G_{20_1} , G_{20_2} ,
5 G_{21_1} , G_{21_2} comprises the relative weighting ratio of the risk elements 1410, 1411, 1412 and/or protection elements 1510, 1511, 1512 with respect to one another. For each risk element 1410, 1411, 1412 and protection element 1510, 1511, 1512, a facility-specific quality
10 factor Q_{20_1} , Q_{20_2} , Q_{21_1} , Q_{21_2} is determined by the capture module 11 via corresponding interfaces by means of a respective measuring and/or capture device 111, 112, 113, 114. The measuring devices and/or capture devices 111, 112, 113, 114 can be connected to the
15 capture module 11 unidirectionally and/or bidirectionally directly or via a network. The measuring devices and/or capture devices 111, 112, 113, 114 can comprise corresponding sensors and/or input elements, particularly also manual input elements such
20 as, e.g. keyboard, mouse pad etc. If the connection between the measuring devices and/or the capture devices 111, 112, 113, 114 and the capture module 11 is effected via a network, the network can comprise, for example, a GSM or an UMTS network, or a satellite-based
25 mobile radio network, and/or one or more landline networks, for example the public switched telephone network, the worldwide Internet or a suitable LAN (local area network) or WAN (wide area network). In particular, it also comprises ISDN and XDSL
30 connections.

The quality factor Q_{20_1} , Q_{20_2} , Q_{21_1} , Q_{21_2} comprises the facility-specific instance of a risk element 1410, 1411, 1412 or protection element 1510, 1511, 1512 based
35 on the measured facility data 201, 202, 211, 212. On the basis of the sum of the products of the risk elements 1410, 1411, 1412 with associated weighting factors G_{20_1} , G_{20_2} , G_{21_1} , G_{21_2} and quality factors Q_{20_1} , Q_{20_2} , Q_{21_1} , Q_{21_2} , combined with the sum of the products

of the protection elements 1510, 1511, 1512 with associated weighting factors $G20_1$, $G20_2$, $G21_1$, $G21_2$ and quality factors $Q20_1$, $Q20_2$, $Q21_1$, $Q21_2$, the evaluation module 12 determines at least one risk analysis value
5 for the automated risk management and/or facility optimization value for the automated optimization of at least one protection device or minimization of a risk potential of the technical facility.

10 As a variant of an embodiment, the optimization system can generate, and store in a memory module 17 of the optimization system 10, at least two facility risk types 170, 171. The facility risk types 170, 171 in each case comprise at least one risk element 1410,
15 1411, 1412 and/or one protection element 1510, 1511, 1512, wherein each technical facility 20, 21 can be allocated to one facility risk type 170, 171. Figure 2 diagrammatically illustrates a facility risk type RA which comprises one or more risk elements RE_1 and/or
20 one or more protection elements SE_1 and a weighting factor GR_1 and GS_1 and a quality factor QR_1 and QS_1 is stored allocated to each RE_1 and SE_1 , respectively. It can be advantageous if the facility risk types are generated in such a manner that the allocation to a
25 technical facility is unambiguous. For each facility risk type 170, 171, one reference value is generated and the facility data 201, 202, 211, 212 of different technical facilities 20, 21 are normalized by means of a normalization module 18 on the basis of the reference
30 value of the allocated facility risk type 170, 171. The facility risk types 170, 171 and/or the associated reference values can be generated, for example, dynamically. This means that the different facility risk types can thus be normalized at any time on the
35 basis of up-to-date values since the most up-to-date data for the technical facilities 20, 21 are available at any time with the capture modules 11. To combine the sum of the products of the risk elements 1410, 1411, 1412 with associated weighting factors $G20_1$, $G20_2$, $G21_1$,

G21₂ and quality factors Q20₁, Q20₂, Q21₁, Q21₂ with the sum of the products of the protection elements 1510, 1511, 1512 with associated weighting factors G20₁, G20₂, G21₁, G21₂ and quality factors Q20₁, Q20₂, Q21₁, Q21₂, a
5 two-dimensional matrix table, for example, can be generated and stored in which a first dimension is allocated to the protection level (sum of the products of the protection elements 1510, 1511, 1512 with associated weighting factors G20₁, G20₂, G21₁, G21₂ and
10 quality factors Q20₁, Q20₂, Q21₁, Q21₂) of a technical facility 20, 21 and a second dimension is allocated to the risk level (sum of the products of the risk elements 1410, 1411, 1412 with associated weighting factors G20₁, G20₂, G21₁, G21₂ and quality factors Q20₁,
15 Q20₂, Q21₁, Q21₂) of a technical facility 20, 21 (Figure 3/4). For the automated risk management and/or automated optimization of the service life of the technical facility 20, 21, the sum of the products of the protection elements 1510, 1511, 1512 with
20 associated weighting factors G20₁, G20₂, G21₁, G21₂ and quality factors Q20₁, Q20₂, Q21₁, Q21₂ of the technical facility 20, 21 is transferred in the first dimension and the sum of the products of the risk elements 1410, 1411, 1412 with associated weighting factors G20₁, G20₂,
25 G21₁, G21₂ and quality factors Q20₁, Q20₂, Q21₁, Q21₂ of the technical facility 20, 21 is transferred in the second dimension. The at least one risk analysis value and/or the at least one facility optimization value are determined on the basis of the location of the entry in
30 the matrix table. The matrix table can be divided, e.g. into predefinable sectors (Figure 3/4), wherein one sector corresponds to at least one definable risk analysis value and/or facility optimization value. The matrix table can be normalized by means of a facility-
35 risk-type-specific normalization factor, e.g. for determining the risk analysis values and/or facility optimization values for a technical facility 20, 21. The facility-risk-specific normalization factor can be generated dynamically on the basis of available

facility data of technical facilities 20, 21 of the corresponding facility risk type 170, 171. The dynamic generation provides for, e.g. a normalization of the matrix table which is up-to-date at any time as a
5 result of which even subtle changes in the corporate culture and/or management of the technical facilities 20, 21 can also be taken into consideration. The scale of the first and/or second dimension of the matrix table can be selectable, e.g. linearly or nonlinearly.
10 As a result, even complex nonlinear processes but also simple linear dependencies can also be taken into consideration depending on the risk type of the industry. As a special variant of an embodiment, it may be appropriate to select an identical matrix table for
15 all industry types measured. By means of the matrix table it is easily possible for a user, for example, to optimize a technical facility 20, 21 with respect to its protection elements and/or risk elements, and/or to adapt it to a general standard. The latter may be of
20 significance, e.g. during the automatic determination of insurance premiums. In addition, the user can use the matrix table to balance and/or adapt his portfolio in simple manner, e.g. with respect to investment risk in the case of risk management for portfolios of
25 securities. Figure 4 shows such a balanced and/or adapted distribution and Figure 3 shows an unbalanced distribution within the matrix table.

As an extension, the risk analysis values and/or
30 facility optimization values for possible combinations and weightings of the protection elements 1510, 1511, 1512 and/or risk elements 1410, 1411, 1412 can be automatically generated and stored accessible to a user, e.g. by means of an extrapolation module 19. The
35 extrapolation module 19 can be used for optimizing, e.g. the protection elements and/or risk elements by automatic means in that the extrapolation module 19 looks for a corresponding local or global extreme and indicates it to the user. For this purpose, other

factors and/or boundary conditions can also be taken into consideration by the extrapolation module 19, such as, for example, time factors and/or financial aspects such as, e.g. the required investment in order to achieve such optimization of the technical facility 20, 21. It may also be appropriate if a group risk factor is allocated to each facility risk type 170, 171 by means of the evaluation module 12, wherein the group risk factor comprises the overall risk of all technical facilities of a facility risk type 170, 171. In this variation of an embodiment, too, it may be advantageous for particular applications that the group risk factor is generated dynamically by means of the evaluation module 12. This can be achieved on the basis of the facility data of the capture modules 11 and/or other up-to-date data such as, e.g. Internet enquiries or enquiries from networked status databases of the technical facilities 20, 21.

It is of importance to point out that, naturally, the capture module 11 can be arranged to be accessible centrally and/or decentralized via a network 50 in the optimization system 10. In the latter possibility, the system 10 can also be offered as network service, i.e., e.g. as Internet service by a service provider for operators of technical facilities 20, 21. The communication network 50 can comprise, for example, a GSM or an UMTS network, or a satellite-based mobile radio network and/or one or more landline networks, for example the public switched telephone network, the worldwide Internet or a suitable LAN (local area network) or WAN (wide area network). In particular, it also comprises ISDN and XDSL connections. Corresponding enquiries can also be made by a user, e.g. by means of a communication terminal via the network 50. In this process, data such as texts, graphics, images, maps, animations, moving pictures, video, QuickTime, sound recordings, programs (software), program-accompanying data and hyperlinks or references to multimedia data

can be used for communication. This includes, e.g. also MPx (MP3) or MPEGx (MPEG4 or 7) standards as defined by the Moving Picture Experts Group. In particular, the multimedia data can comprise data in the HTML (hyper
5 text markup language), HDML (handheld device markup language), WMD (wireless markup language), VRML (virtual reality modeling language) or XML (extensible markup language) format. The communication terminal of the user can be, for example, a PC (personal computer),
10 TV, PDA (personal digital assistant) or a mobile radio device (particularly e.g. in combination with a broadcast receiver). The possibility of an enquiry by the user made at any time may be appropriate, particularly for portfolio management, so that he can
15 respond rapidly and reliably, e.g. to changed risk conditions.

Finally, it may also be appropriate that groups of protection elements 1510, 1511, 1512 are formed as
20 knock-out protection elements with one or more protection elements 1510, 1511, 1512 by means of the evaluation module 12. A knock-out protection element determines and/or dominates the behavior or the influence of the entire group with respect to the
25 evaluation of the optimization system 10 when a given limit value of the knock-out protection element is reached. For example, the availability of fire extinction water and the distance from the nearest local fire department can be defined as protection
30 elements for a specific technical facility 20, 21. If, in contrast, there is no fire extinction water, this factor directly also influences the functioning of the protection element "fire department". Such dependences, e.g., can also be taken into consideration additionally
35 by means of knock-out protection elements.